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(54) **Separation of a donor web from a protective layer lamination over an image produced by a thermal printer**

(57) The printer includes a guide member (40) downstream of a thermal head (12) so as to define respective paths for a web support (26) and a receiver medium (28) between the thermal head (12) and respective take-up spools (14, Fig. 1) and (16, Fig. 1). A transport system moves the donor web (26) and the receiver medium (28) in a forward direction along their respective paths (i) past the thermal head (12), whereat heat from the thermal head (12) causes an area of a laminate material to transfer from the web support (26) to the receiver medium (28), ii) past the guide member (40) whereat the donor web support (26) and the receiver medium (28) separate at an angle β, and (iii) to their respective take-ups along their respective paths such that the area of the laminate material which is transferred to the receiver medium (28) breaks cleanly from a non-laminated area of the laminate material that remains on the web support (26) as the web support (26) separates from the receiver medium.

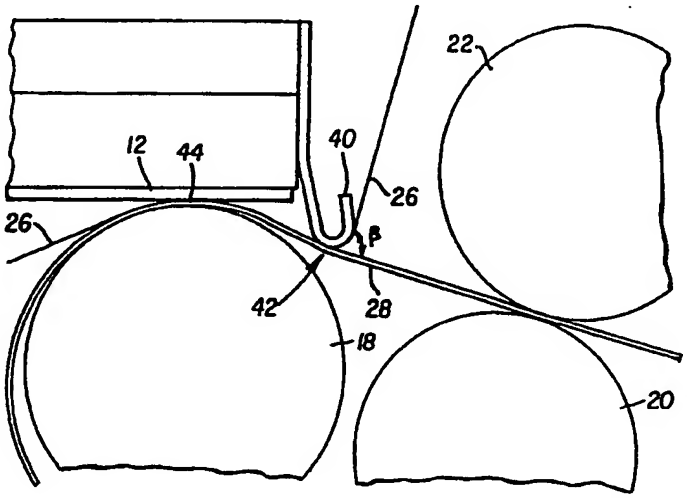

FIG. 6

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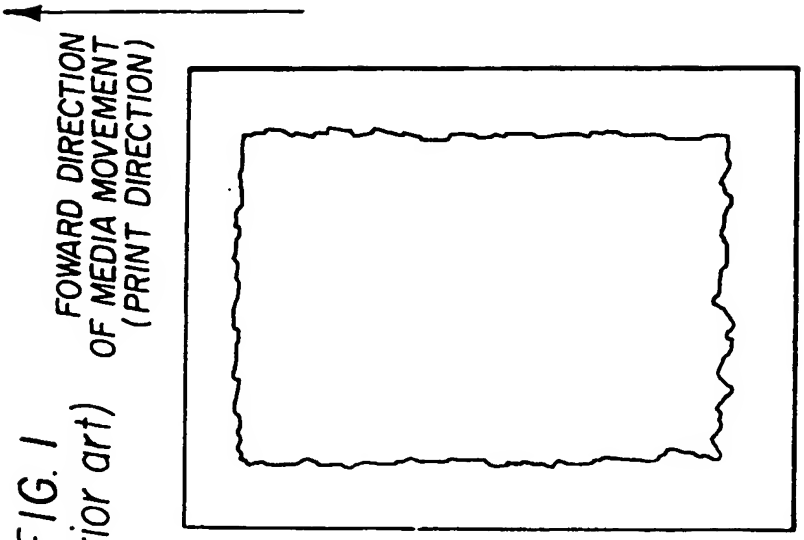


FIG. 1
(prior art)

FIG. 2

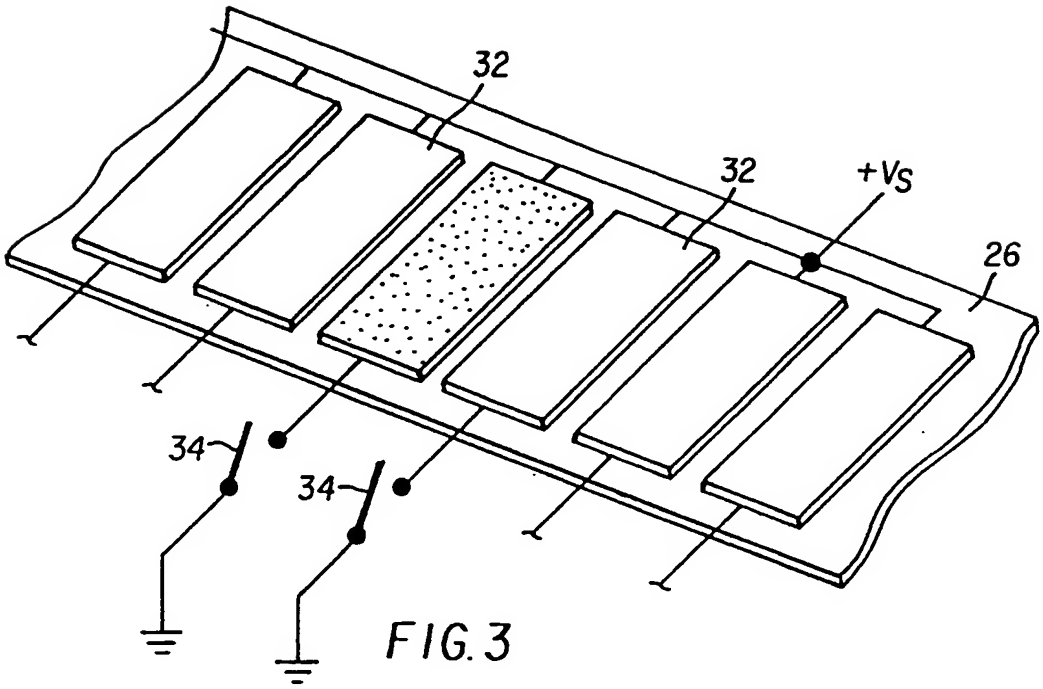

32
32
+Vs
26
34
34

FIG. 3

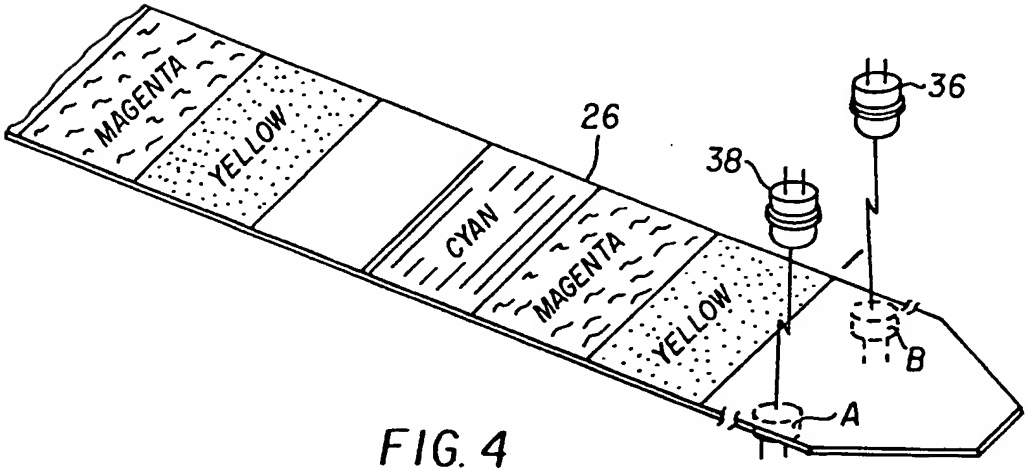
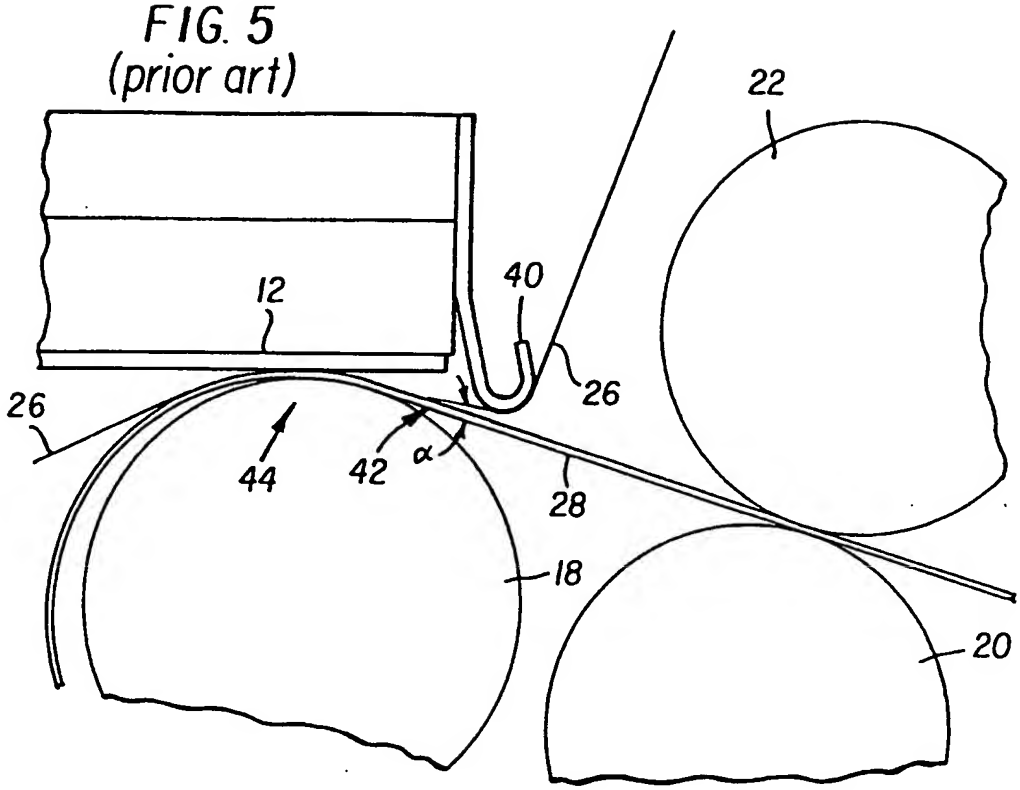

MAGENTA
YELLOW
CYAN
MAGENTA
YELLOW
26
36
38
B
A

FIG. 4

FIG. 5
(prior art)



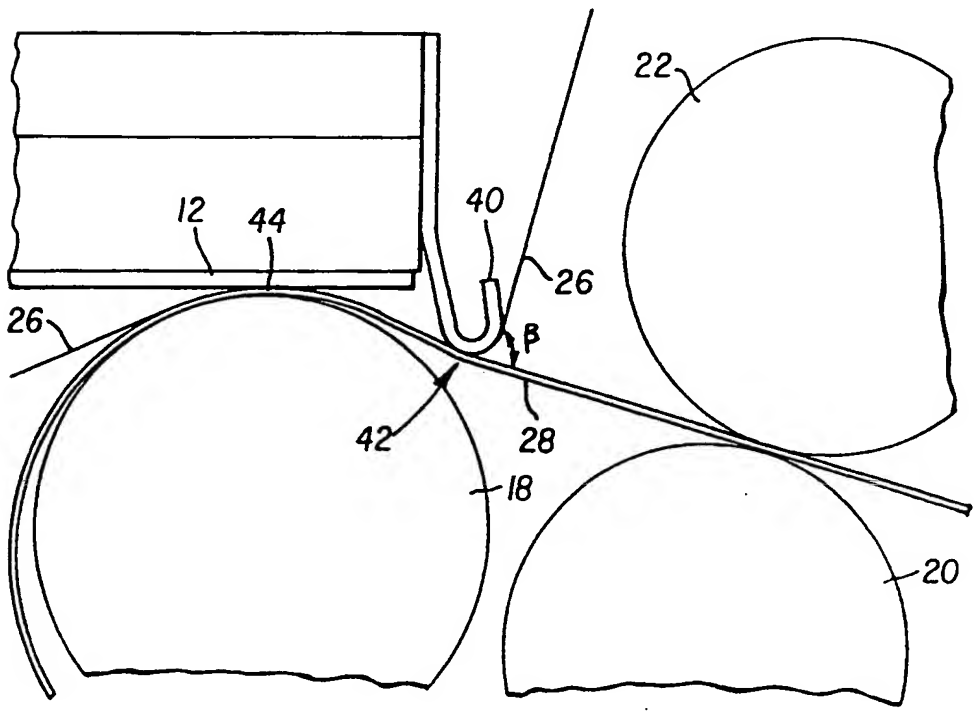


FIG. 6

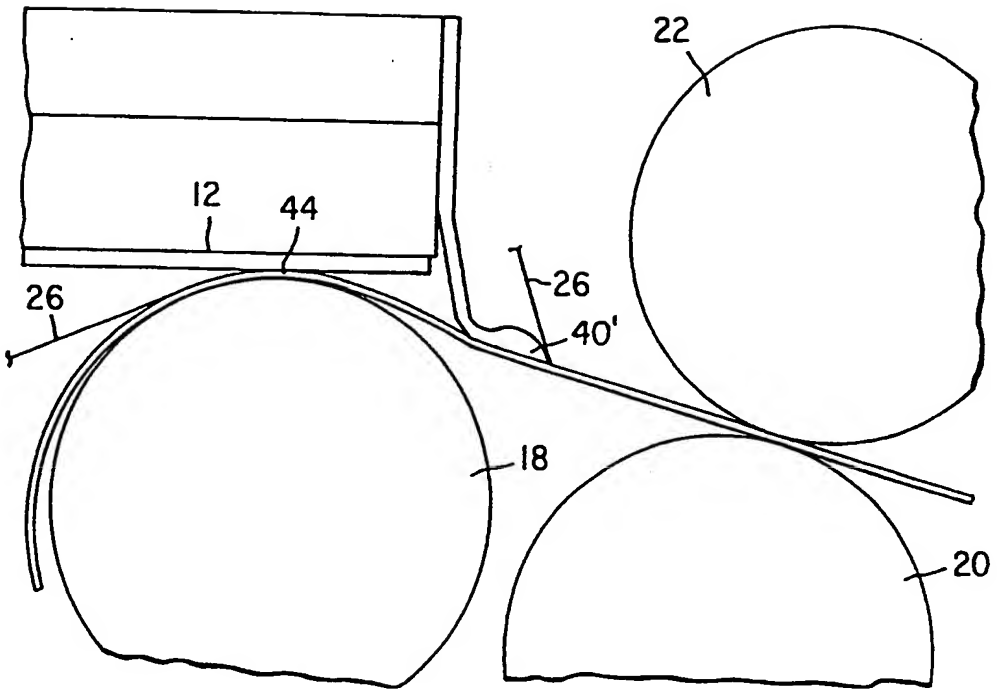


FIG. 7

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SEPARATION OF A DONOR WEB FROM A PROTECTIVE LAYER LAMINATION OVER AN IMAGE PRODUCED BY A THERMAL PRINTER

Field of the Invention

This invention relates generally to thermal printers having a transport system for moving a receiver medium and a dye-donor web past a thermal print head to transfer a dye image to the receiver medium; and more particularly to such printers wherein the dye-donor web carries a thermally-transferable laminate material that can be applied onto the receiver medium over the dye image to form a protective layer.

Background of the Invention

Thermal dye images suffer from handling-induced artifacts. Fingerprints are especially of concern, as the body chemicals seriously deteriorate the dye image. It is known to apply a protective layer on top of the dye image using thermally-transferable laminate materials. For example, see U.S. Patent No. 4,738,555, which issued to M. Nagashima on April 19, 1988. The thermally-transferable laminate material that forms the protective layer is carried as a separate patch on the dye-donor web, and is transferred by applied heat from the print head.

Problem to be solved by the Invention

Often, a problem occurs during the process of transferring the laminate material from the dye-donor web to the receiver medium. The portion of the thermally-transferable material that is actually laminated to the receiver medium tends to not break away cleanly from the non-laminated portion of the thermally-transferable material, leaving ragged, uneven edges as shown in Figure 1 of the accompanying drawings. Prior attempts to solve this problem, such

as that described in UK Patent Application GB 2,258,843 which was published on February 24, 1993, involved the application of excess thermal energy at the lamination edges.

Summary of the Invention

It is an object of the present invention to apply a protective layer over a thermal dye image on a receiver medium using a thermally-transferable laminate material which is carried as a separate patch on the dye-donor web, and is transferred by heat from the print head with a sharp, straight leading and/or side edges without the application of excess thermal energy.

It is another object of the present invention to produce a uniform separation of a laminate at the leading and/or side edges of the lamination by utilizing a donor guide to control the separation point and the separation angle.

In accordance with one aspect of the present invention, there is provided a printer adapted to thermally-transfer an area of laminate material from a web support to a receiver medium, with the web support and receiver medium being peeled apart at an angle and then advanced in respective directions to respective take-ups after transfer; said printer including a thermal head; a platen adjacent the thermal head to press a web support and a receiver medium against the thermal head; and take-ups for the web support and the receiver medium; characterized by a guide member spaced downstream of the thermal head and the platen in the direction of travel of the web support so as to define respective paths for the web support and the receiver medium between the thermal head and the respective take-ups, said paths being adjacent to each other from the thermal head and the platen to the

guide member such that the web support and the receiver medium are held together and diverging beyond the guide member so as to separate in a forward direction, the web support and the receiver medium paths turning around the guide member different amounts to define respectively different wrap angles; and a transport system for moving the web and the receiver medium in said forward direction along their respective paths past the thermal head whereat heat from the thermal head causes an area of a laminate material coating to transfer from the web support to the receiver medium, past the guide member whereat the web support and the receiver medium separate at a large angle, and to their respective take-ups along their respective paths such that the area of the laminate material which is transferred to the receiver medium breaks cleanly from a non-laminated area of the laminate material that remains on the web support as the web support separates from the receiver medium.

A thermal printer is disclosed which includes a guide member downstream of the thermal head so as to define respective paths for the web support and the receiver medium between the thermal head and respective take-ups. The respective paths are adjacent to each other between the thermal head and the guide member so that the web support and the receiver medium are held together and diverge beyond the guide member so as to separate in a forward direction. A transport system moves the donor web and the receiver medium in the forward direction along their respective paths (i) past the thermal head, whereat heat from the thermal head causes an area of the laminate material coating to transfer from the web support to the receiver medium, (ii) past the guide member whereat the donor web support and the receiver

medium separate at a large angle, and (iii) to their respective take-ups along their respective paths such that the area of the laminate material which is transferred to the receiver medium breaks cleanly from a non-laminated area of the laminate material that remains on the web support as the web support separates from the receiver medium.

In a preferred embodiment of the present invention, the web support and the receiver medium paths turn around the guide member to define respective wrap angles. The wrap angle defined by the web support is substantially greater than the wrap angle defined by the receiver medium.

Brief Description of the Drawings

For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings in which:-

Figure 1 is a top plan view of a receiver medium with a thermally-transferable material laminated over a portion thereof according to the prior art;

Figure 2 is a schematic of a thermal printer which can be employed to make color images in a dye receiver medium;

Figure 3 is a schematic perspective of several heating elements used in the print head of the printer of Figure 2;

Figure 4 shows a portion of a typical dye-donor web;

Figure 5 is a side elevation view, partially in section illustrating the dye-donor web and the receiver medium during laminate separation at the leading edge of the lamination according to the prior art;

Figure 6 is a side elevation view similar to Figure 5, but showing the dye-donor web and the receiver medium during laminate separation when the apparatus has been arranged according to the present invention; and

Figure 7 is a side elevation view similar to Figure 6, but showing the dye-donor web and the receiver medium during laminate separation when the apparatus has been arranged according to a second embodiment of the present invention.

Detailed Description of the Invention

The present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art. While the invention is described below in the environment of a dye-sublimation thermal printer, it will be noted that the invention can be used with other types of thermal printers.

Referring to Figure 2, a thermal printer 10 includes a print head assembly 12 and dye-donor web supply and take-up spools 14 and 16, respectively. A main printer support structure includes a roller platen assembly 18, a pair of dye receiver medium transport mechanism pinch rollers 20 and 22, and a dye receiver medium supply 24.

Normal thermal printer operations include loading dye receiver medium, printing information upon the dye receiver medium and ejecting the finished print. Each of these operations is fully described in commonly-assigned U.S. Patent No. 5,176,458, which issued to H.G. Wirth on January 5, 1993.

Printer operation begins with a loading phase, in which print head assembly 12 moves to a loading position. A dye-donor web 26 and a sheet 28 of dye receiver medium advance along converging paths to a printing location, and print head assembly 12 is positioned in preparation for the printing operation.

As a sheet 28 of dye receiver medium advances, it moves along a guide 30 to follow a curved path toward a gap between print head assembly 12 and platen assembly 18. As the dye receiver medium moves into this gap, it contacts dye-donor web 26 and is guided toward dye receiver medium transport mechanism pinch rollers 20 and 22. While this embodiment describes dye receiver medium in sheet form, dye receiver medium supplied in roll form could also be utilized.

Once dye receiver medium 28 is firmly held by dye receiver medium transport mechanism pinch rollers 20 and 22, print head assembly 12 moves toward platen assembly 18, pressing dye-donor web 26 and dye receiver medium 28 against platen assembly 18 to form a sandwich for thermal printing.

When the loading phase is completed, printer 10 enters a printing phase, during which print head assembly 12 presses dye-donor web 26 and dye receiver medium 28 into platen assembly 18, and prints information on the dye receiver medium.

Referring to Figure 3, the print head of print head assembly 12 includes a plurality of heating elements 32, such as electrical resistors, which are pressed against dye-donor web 26 to force the dye-donor web against dye receiver medium 28. When one of a plurality of switches 34 is closed, the associated heating element 32 is connected to a voltage potential

source V_S. The amount of dye transferred is a function of the time period that switch 34 is closed.

Dye-donor web 26 comprises a leader portion followed by a repeating series of dye frames. The dye frames may be contiguous as shown or spaced by interframe regions, and, as shown in Figure 4, each series includes in sequence yellow, magenta, and cyan dye frames. A single series is used to print one color plane on dye receiver medium 28.

In this disclosure, the term "dye" refers to a colored material which transfers from the dye-donor web to a dye receiver medium in response to energy applied by individual elements of the print head. According to the illustrated embodiment of the present invention, each of the repeating series of dye frames on dye-donor web 26 is followed by a frame coated with laminate material. The laminate material is preferably clear, and also transfers from the dye-donor web to a dye receiver medium in response to energy applied by individual elements of the print head. While the laminate material is shown carried by the dye-donor web, those skilled in the art will understand that the laminate material may be carried by a separate web and applied over the image at a lamination station downstream of the print head.

Although the print head is shown as having electrically resistive heating elements 32, those skilled in the art will understand that other sources of energy such as, diode laser array and individual lasers have been and can be effectively used in accordance with this invention. After a color plane is formed on the dye receiver medium, the dye receiver medium will be referred to as a print.

As shown, there are two LEDs 36 and 38 which illuminate the dye-donor web from above. LED 36 emits

green light and LED 38 emits blue light. Two photodetectors "A" and "B" are disposed below the dye-donor web and receive light which passes through the dye-donor web. Photodetectors "A" and "B" provide a signal for identifying the start of series and each individual color dye frame in such series. For a more complete discussion of this identification, reference is made to commonly assigned U.S. Patent No. 4,710,781 to S. Stephenson, the disclosure of which is incorporated by reference herein. It will be understood to those skilled in the art that other types of well known apparatus can be used to identify the start of each series of colored dye frames. See for example U.S. Patent No. 4,893,951.

Thus, color thermal printers form a print by successively printing a single color onto a receiver medium, and returning the receiver medium to the beginning point; whereupon another color is printed. This process continues until all the required colors on the dye-donor web have been printed onto the receiver medium. To apply the laminate materials over the dye image, the printer repeats the above process for the additional patch of laminate material on the dye-donor web. That is, the print head is raised, and the dye-donor web is moved to the beginning of a patch of thermally-transferable laminate material. The receiver medium is repositioned such that the beginning of the image to be coated aligns with the print head. The print head is then lowered, and the lamination process begins, with the print head applying heat and pressure to the dye-donor web such that the laminate material transfers to the receiver medium.

Referring to Figure 1, note that in a typical print which has been laminated with a

protective material using the above-described process, the edges appear ragged in the figure. It has been determined that the ragged appearance of the edges of the laminate is due, at least in part, to the differences in the angle of separation of the dye-donor web from the receiver medium.

In way of explanation, compare Figures 5 and 6, which are side elevation views, partially in section, illustrating the paths of the dye-donor web and the receiver medium during laminate separation according to the prior art (Figure 5) and a preferred embodiment of the present invention (Figure 6). Referring first to Figure 5, note that downstream from print head 12, a donor guide 40 is used to control the separation point 42 of dye donor medium web 26 and receiver medium sheet 28 allowing each to follow its own path.

When a color plane is printed, print head 12 is raised and dye donor web 26 is moved to the next color patch while receiver medium sheet 28 is rewound back to the beginning of the image. The printing process continues for all the required colors. Once the last image data of the last color is printed, print head 12 is raised and dye donor web 26 is moved to the beginning of the laminate patch. The receiver medium sheet is repositioned such that the beginning of the area needed to be laminated aligns with print head 12. The print head is then lowered and the lamination process begins. The print head applies heat to the donor web, which transfers the laminate material to the receiver medium sheet.

During lamination, the separation point 42 (the point at which the laminate on the dye donor web 26 separates from the laminate on the receiver medium sheet) is dependent on the location of donor

guide 40. If the guide is positioned high as shown in Figure 5 separation point 42 is somewhere between nip 44 and donor guide 40. The exact location will depend on separation angle α as well as the donor medium tension, the lamination energy, and the laminate material. It has been determined that in one commercially available printer according to the configuration illustrated in Figure 5, angle α can vary down to approximately 4 degrees. Since separation angle α is small, the polymer chain in the laminate material does not break easily. Therefore, separation point 42 is not constant for every position down the page, thus creating a ragged edge on two sides of the lamination patch.

By lowering donor guide 40, according to a feature of the present invention, to the position as shown on Figure 6, separation of the dye donor web and the receiver medium between the heat line on print head 12 and donor guide 40 is eliminated. As soon as the donor and receiver sandwich passes the donor guide, the guide forces the dye donor web to take a sharp turn away from the receiver medium, creating a uniform separation. With this configuration, the separation point is at the same place for every position down the page. In addition, the new separation angle β is now much larger than the previous separation angle α which yields a uniform separation at the side edges. Angle β is preferable in the approximate range of between 90 degrees and 110 degrees, and is preferable about 100 degrees.

An even better result can be obtained by changing the shape of the donor guide, as the shape of the donor guide controls the separation angle β. The larger the angle, the better is the result. Having a large peel-apart angle is important because the

polymer chains in the laminate material tend to break cleanly, forming a straight line. Figure 7 shows an example of a variation of the shape of the donor guide.

The above process/method would also work for a thermal printer in which the lamination is applied at a separate station from that at which the image was printed.

When the printing phase is completed, printer 10 enters an ejecting phase, during which the print head assembly is retracted from the platen assembly and the finished print is ejected from the printer. When print head assembly 12 is in the ejecting position, dye receiver medium transport mechanism rollers 20 and 22 captures the dye receiver medium to drive the completed print out of thermal printer 10. When the ejecting phase of the printer operation is finished, the printer is ready to begin another printing operation.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

CLAIMS:

1. A printer (10) adapted to thermally-transfer an area of laminate material from a web support (26) to a receiver medium (28), with the web support and receiver medium being peeled apart at an angle (b) and then advanced in respective directions to respective take-ups after transfer; said printer including a thermal head (12); a platen (18) adjacent the thermal head to press a web support and a receiver medium against the thermal head; and take-ups for the web support and the receiver medium; characterized by a guide member (40) spaced downstream of the thermal head and the platen in the direction of travel of the web support so as to define respective paths for the web support and the receiver medium between the thermal head and the respective take-ups, said paths being adjacent to each other from the thermal head and the platen to the guide member such that the web support and the receiver medium are held together and diverging beyond the guide member so as to separate in a forward direction, the web support and the receiver medium paths turning around the guide member different amounts to define respectively different wrap angles; and a transport system for moving the web and the receiver medium in said forward direction along their respective paths past the thermal head whereat heat from the thermal head causes an area of a laminate material coating to transfer from the web support to the receiver medium, past the guide member whereat the web support and the receiver medium separate at a large angle, and to their respective take-ups along their respective paths such that the area of the laminate material which is transferred to the receiver medium breaks cleanly from a non-laminated area of the

laminate material that remains on the web support as the web support separates from the receiver medium.

2. A printer as defined in Claim 1, wherein the wrap angle defined by the web support around the guide member is substantially greater than the wrap angle defined by the receiver medium.

3. A printer as defined in Claim 2, wherein the different wrap angles defined by the web support and the receiver medium paths around the guide member result in an angle of separation between the web support and the receiver medium greater than approximately 90 degrees.

4. A printer as defined in Claim 2, wherein the different wrap angles defined by the web support and the receiver medium paths around the guide member result in an angle of separation between the web support and the receiver medium between approximately 90 degrees and 110 degrees.

5. A printer as defined in Claim 2, wherein the different wrap angles defined by the web support and the receiver medium paths around the guide member result in an angle of separation between the web support and the receiver medium of approximately 100 degrees.

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Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9510122.6
Relevant Technical Fields (i) UK Cl (Ed.N) B6C (CSAD, CBQC); B6F (FBH, FPA, FPB, FPX) (ii) Int Cl (Ed.6) B41J (2/315, 2/32, 2/325)	Search Examiner G WILLIAMS Date of completion of Search 28 JULY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASE: WPI	Documents considered relevant following a search in respect of Claims :- 1-5

Categories of documents

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Category	Identity of document and relevant passages		Relevant to claim(s)
A	GB 2258843	(DAI NIPPON) see whole document	1
A	US 4815872	(TOSHIBA) see whole document	1
A	US 4738555	(TOSHIBA) see whole document	1

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